APPRENTICESHIP TRAINING

TRANSPORT REFRIGERATION MECHANIC Program

Alberta
MANPOWER
Apprenticeship and Trade Certification

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COURSE OUTLINE

TRANSPORT REFRIGERATION MECHANIC TRADE

THE GOAL OF APPRENTICESHIP TRAINING

To develop a competent tradesman who, through skill and knowledge, is capable of repairing any of the intricate units which constitute modern transport refrigeration or heating units used to heat or cool the load.

THE PRODUCT OF APPRENTICESHIP — a graduate who will:

★ Repair, maintain and operate by skill and knowledge gained through training and experience any of the working parts of spark ignition or diesel engines as well as the various components of mobile refrigeration/heating equipment used to heat or cool the load.

★ Use, competently, both hand and power tools in order to carry out repairs according to manufacturer's specifications.

★ Read and understand work orders, prepare estimates, and interpret technical manuals and diagrams.

★ Write service reports, diagnose the cause of failures and keep service analysis records.

★ Be familiar with the work in related trades such as Machinist and Welder. Outstanding individuals may advance to service representatives or supervisory positions.

TRANSPORT REFRIGERATION MECHANIC
APPRENTICESHIP INFORMATION

Basic Requirements:

★ Indenture for three periods of Trade experience.

★ Attend an eight week technical training course in the first period, second period and third period.

★ Fulfill the requirements for each period including 1800 hours of work experience exclusive of time spent at the training course; successfully complete the technical training course and obtain a satisfactory employer's report.

★ Education — a minimum requirement is the completion of grade 9 or a pass on an equivalent entrance examination as prescribed by the Trade regulation. (Emphasis on Math and physics is advisable).

★ Age — the minimum age for apprentices is 16 years. There is no upper age limit.

Credits:

★ Accelerated patterns of apprenticeship may be granted for related technical training and/or experience.

Benefits:

★ Apprenticeship is a learning-while-earning program. While working at the trade during apprenticeship, apprentices are assured by regulation of a minimum percentage of the journeyman rate: 60% during the first period, 75% during the second period, 90% during the third period. Progress from one rate to the next takes place only after successful completion of all the requirements for each period.

★ All apprentices 17 years of age and older are normally eligible for training allowances while attending technical training courses. These allowances are funded by the Canada Employment and Immigration Commission.

★ Administrative procedures establishing the amount of training allowance is complex and can vary with an individual's circumstances. Contact a local Canada Employment Centre for details.

★ An apprentice who successfully completes the program will graduate with an Alberta Completion of Apprenticeship Certificate and a Certificate of Qualification.

★ The most significant benefit to the graduate apprentice is that he is well trained in technical and practical aspects of the trade and is able to make a worthwhile and productive contribution to society. Society in return, will provide an opportunity for an above-average income and successful livelihood.

DIRECTIONS FOR PROSPECTIVE APPRENTICES

★ Contact your nearest Apprenticeship and Trade Certification office for detailed information and counselling (see list of offices on page 51).

★ Obtain an application form from the Apprenticeship and Trade Certification office and neatly complete, in full, the information requested of the apprentice.

★ Persevere in the search for apprentice employment and upon obtaining employment, give the application to the employer. It should be completed and returned to an Apprenticeship and Trade Certification office forthwith.

★ Any time credit, for previous experience in the Transport Refrigeration Mechanic trade, should be discussed with the employer and requested on the application form by the employer.

★ Attach to the apprentice application a copy (transcript) of the marks for your last year of school. Applicants who do not have their school transcripts or a grade nine standing are required to write an entrance examination. If transcripts have been lost, contact Alberta Education for information on school transcripts.

★ Prepare to be called for an entrance examination following submission of your application. You will be advised of the date, time and location.

★ A contract of apprenticeship is entered into between the apprentice and the employer and should be signed within 90 days after the apprentice application has been approved. If contracts have not been issued within this time, contact the Apprenticeship and Trade Certification office.

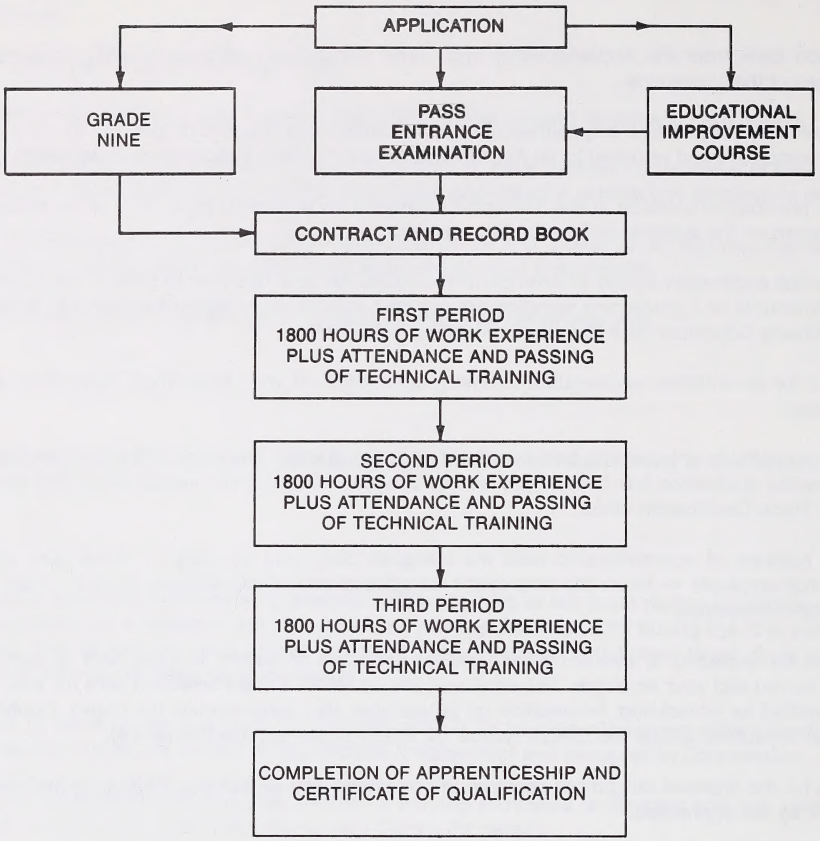
★ Before signing the contract of apprenticeship read the complete document carefully — know your obligations and responsibilities to your employer — know the employer's obligations and responsibilities to you — feel confident you have selected the right occupation.

★ Know when you will be expected to attend classes and be prepared to attend. In early May of each year, School Schedules are sent to you and your employer. The employer also receives a class selection card for you, which is to be completed and submitted for scheduling. Information on procedures also accompanies the above. Confirmation on the date you actually get scheduled and/or the Official Notice will follow at the appropriate time(s).

★ Prepare in advance for the financial obligations required of you during school training. Reference materials and school supplies are paid for by the apprentice.

★ While an apprentice, it will be your responsibility to respond promptly to mailed directions and requests from Apprenticeship and Trade Certification.

APPRENTICESHIP ROUTE TOWARD CERTIFICATION



APPRENTICESHIP COMMITTEE STRUCTURE

Transport Refrigeration Mechanic Provincial Apprenticeship Committee

The Provincial Apprenticeship Committee for the Transport Refrigeration Mechanic Trade is comprised of members from Local Apprenticeship Committees from the cities of Edmonton and Calgary.

This Committee is concerned with the policies that guide the program and make recommendations to the Apprenticeship and Trade Certification Board and the Executive Director of Apprenticeship and Trade Certification in the following areas:

- ★ Contribute current information relative to changes in the trade and requirements of industry.
- ★ Make recommendations for changes to existing trade regulations.
- ★ Assist in updating of the training program through recommendations for revisions to the course outline and attendant examinations.

Transport Refrigeration Mechanic Local Apprenticeship Committee

Local Apprenticeship Committees are concerned with individuals and trade situations within a local region. Meetings are held throughout the year to make recommendations and to discuss problems relating to the apprenticeship program. Members who serve on committees are nominated by employer and labour organizations, and membership is equally divided into employer and employee representation in accordance with The Manpower Development Act.

Apprenticeship Committee Members:

Mr. L. Campbell — Edmonton — Employer
Mr. C. F. Maleski — Edmonton — Employer
Mr. B. G. Meehan — Edmonton — Employee
Mr. W. G. Tomlinson — Edmonton — Employee
Mr. J. Yewchuk — Edmonton — Employer (Alternate)
Mr. R. A. Armstrong — Edmonton — Employee (Alternate)
Mr. L. W. Fleming — Calgary — Employer
Mr. F. Gosteli — Calgary — Employer
Mr. W. Davidson — Calgary — Employee
Mr. G. G. Jackson — Calgary — Employee
Mr. L. L. Aitkens — Calgary — Employer (Alternate)
Mr. R. D. Drinnon — Calgary — Employee (Alternate)

TRANSPORT REFRIGERATION MECHANIC PROGRAM
COURSE OUTLINE

This outline has been prepared in accordance with recommendations from the Provincial Apprenticeship Committee for the Transport Refrigeration Mechanic Trade in the Province of Alberta.

The outline was updated following consideration given to recommendations and suggestions from:

Local Apprenticeship Committees
Representatives from training institutes
Curriculum Sub-Committee from the Provincial Apprenticeship Committee

PROCEDURES FOR RECOMMENDING REVISION(S) TO THE COURSE OUTLINE

Any concerned citizen or group in the Province of Alberta may make recommendations for change by writing to Apprenticeship and Trade Certification,Edmonton.

It is requested that recommendations for change refer to specific areas and state references used. Recommendations received will be placed before regular meetings of the Provincial Apprenticeship Committee.

PREFACE

The Ratio of Theory and Shop

★ In the interest of flexibility, the outline for the Transport Refrigeration Mechanic Trade is not divided into identified theory and shop divisions.

★ The preferred 50% shop and 50% theory ratio may have to be deviated from at times as certain items of subject material cannot be effectively covered within this ratio.

Mathematics and Sciences (Related Subjects)

★ The subjects of mathematics and science have been determined as being integral components of the technical training when they are applied in the strictest terms of trade involvement.

★ These knowledge areas, therefore, are more realistically recognized as being actually theory items in the trade coverage, rather than mathematics and science as self-supporting subject entitites.

SAFETY EDUCATION

Safe working procedures and conditions, accident prevention and the preservation of health is of primary importance in the Apprenticeship programs in Alberta. These responsibilities are shared and require the joint efforts of the government, employers, employees and the general public. Therefore, it is imperative that all parties become aware of circumstances that may lead to injury or harm and that safe learning experiences and environment can be created by controlling the variables and behaviors that may contribute to or cause an accident and/or an injury.

It is generally recognized that a safe attitude contributes to an accident free environment. As a result a healthy safe attitude towards accidents will benefit an employee by helping to avoid injury, loss of time and loss of pay.

A tradesman is possibly exposed to more hazards than any other person in the work force and therefore, should be familiar with the Occupational Health and Safety Act and Regulations dealing with his own personal safety and the special safety rules applying to each job.

LEGAL AND ADMINISTRATIVE ASPECTS

Employer's Responsibilities:

Accident prevention and the provisions of safe working conditions are the responsibilities of an employer. The company is responsible for:

1. The provision and maintenance of safety equipment
2. The provision of protective devices and clothing (as required by the Occupational Health & Safety Act, General Safety Regulations)
3. The enforcement of safe working procedures
4. Adequate safeguards for machinery, equipment and tools
5. Observance of all accident prevention regulations
6. Adequate training to allow a worker to use or operate equipment in an effective and safe manner.

Government's Responsibilities:

Apprenticeship and Trade Certification in conjunction with the respective Provincial Apprenticeship Committee assumes the responsibility to assure that adequate safety is reflected in the curriculum and that adequate safety instruction is presented at the training establishments.

The Occupational Health and Safety Inspection Branch assumes the responsibility for periodic inspection of the operation to ensure that regulations for industry are being correctly observed.

Individual's Responsibilities:

The employee is responsible for:

1. Knowing and working in accordance with the safety regulations pertaining to job environment and
2. Working in such a way as not to endanger himself or his fellow employees

The major factor in safety is the individual employee, his personal attitude toward safety and having an awareness of the respective safety regulation.

TRANSPORT REFRIGERATION MECHANIC PROGRAM

Subjects and Time Distribution

First Period	**8 Weeks**	**30 Hours Per Week**	**240 Hours**
Section One:	Basic Materials, Tools and Skills		48
Section Two:	Safe Use of Oxy-Acetylene Equipment		12
Section Three:	Refrigeration Theory and Components		180
Second Period	**8 Weeks**	**30 Hours Per Week**	**240 Hours**
Section One:	Refrigeration Review		30
Section Two:	Electrical Theory and Related Mathematics		210
Third Period	**8 Weeks**	**30 Hours Per Week**	**240 Hours**
Section One:	Gasoline and Diesel Engine Theory, Service and Repair		120
Section Two:	Diesel Fuel Injection Systems		45
Section Three:	Gasoline and Propane Engine External Systems		15
Section Four:	Refrigerant Compressors		15
Section Five:	Heaters		25
Section Six:	Records and Reports		20

FIRST PERIOD TECHNICAL TRAINING
TRANSPORT REFRIGERATION MECHANIC
COURSE OUTLINE

SECTION ONE: **48 Hours**

TOPIC	COURSE OBJECTIVES
	Upon successful completion of each section the apprentice should be able to:
A. Terminology	**2 Hours**
1. Standard Terms	1. Understand the terminology associated with industry and be capable of explaining the meaning of the specific terms used.
2. Descriptions, Operational, Material	1. Describe operational units and characteristics of materials as applied to first period technical training.
3. Classification of Terms	1. Explain slang and shop terms with proper terminology.
4. Value of Terminology	1. State the value of using proper terminology.
B. Materials (Metallic)	**2 Hours**
1. Recognition of Metals	1. Recognize the various metals, ferrous and non-ferrous used in the industry: (a) cast iron (b) copper (c) steel (d) stainless steel (e) aluminum (f) brass
2. Uses and Characteristics	1. Identify and state the characteristics of the metals common in the industry and indicate their normal use.
3. Sources of Copper, Cast Iron (Steel) etc.	1. Explain the manufacturing process used to form the metals to the desired shape and state the reason for the use of the different processes.
4. Limitations of a Metal	1. Describe a metal's resistance to heat, ductility, friction, etc. and the results of these and limitations.
5. Tooling Responses of Metal	1. Define the following terms and indicate the characteristics of different metals associated to the terms: (a) hardening (b) annealing (c) tempering (d) quenching (e) drilling (f) cutting (g) fusion
6. Handling and Storing of Materials	1. State the handling and safety techniques when using the metals common to the industry. e.g. uncoiling copper tubing
C. Materials (Non-Metallic)	**2 Hours**
1. Uses and Material Choice	1. Identify the use of non-metallic materials used in the manufacture and maintenance of equipment used in the industry: (a) asbestos (b) neoprene (c) nylon (d) wool (e) fibre glass (f) foams (g) woods

TOPIC	COURSE OBJECTIVES
	2. State the advantages and safety factors associated with the non-metallic materials common in the manufacture and maintenance of equipment common in the industry.
2. Classification	1. Identify materials used as to: (a) natural (b) synthetic
D. Mechanical Measuring Tools	**13 Hours**
1. Basic Fundamentals, SI Systems and Imperial (a) use of simple calculator(conversion to metric) (b) common fractions	1. Use a simple calculator to perform the following functions; addition, subtraction, multiplication, division, square and square root. 2. Calculate using common fractions related to the trade, including: (a) proper and improper fractions (b) adding (c) subtracting (d) dividing and multiplying (e) decimal conversion
2. Metrics as Used to Measure: (a) mass (b) volume (c) area (d) force (e) torque (f) velocity (g) temperature	1. Explain the meaning of the specific terms used and perform the necessary calculations to arrive at unknown quantities in imperial and metric units.
3. Units of Linear Measure	1. Describe and apply units of linear measurement in the Imperial and SI systems.
4. Measuring Tools	1. Demonstrate the proper use of and explain the limitations of: (a) rulers (b) common calipers (c) small-hole gauges (d) telescoping gauges (e) dial indicators in Imperial and SI units (f) outside and inside micrometers in Imperial and SI (g) vernier calipers in Imperial and SI units (h) feeler gauges 2. Explain the value and demonstrate proper care and storage of precision measuring tools.
5. Straightedge Use	1. Explain the use and care of the steel straightedge.
6. Protractors and Dividers	1. Demonstrate the use of protractors and dividers for a given project.
E. Hand Tools (Non-Cutting) Including But Not Limited to:	**2 Hours**
1. Selection, Use and Maintenance of: (a) hammers (b) screwdrivers (c) punches (d) wrenches (non-adjustable) (e) pliers (f) clamps and vises	1. Describe the selection, use and maintenance of hammers, screwdrivers, punches, wrenches, pliers, clamps and vises. 2. Demonstrate proper maintenance and safety precautions of punches and wrenches. 3. Describe the types and sizing of vises, the correct mounting and methods of holding work. 4. Describe the types and uses of soft vice jaws.
2. Pushers and Pullers	1. Describe the selection, use and maintenance of pushers and pullers used in the industry.

TOPIC	COURSE OBJECTIVES
3. Lifting Equipment (a) slings (b) chains (c) hoists (d) jacks —hydraulic —mechanical	1. Demonstrate the safe use of commonly used wire rope slings, synthetic slings, chains, hoists and jacks. 2. Describe the proper care, maintenance, and use of wire and synthetic rope, jacks and hoists.
F. Hand Tools (Cutting) Including But Not Limited to and Selection, Use and Maintenance of:	**13 Hours**
1. Hacksaws	1. Select and install correct blades for a hacksaw (number of teeth) for specific projects. 2. Demonstrate the correct use of hacksaws for cutting different types of material.
2. Files	1. Describe the types of files according to the size and shape, including: (a) stance (b) speed and feed (c) proper holding 2. Select and use files for specific surfaces; i.e. (a) finished surfaces (b) shape of work (c) amount of material to be removed (d) select, install and care for file handles
3. Chisels	1. Select types and sizes of chisels and demonstrate the correct use of. 2. Describe the variations of hardness in the different areas of a chisel. 3. Demonstrate the correct sharpening and shaping of chisel ends (points and heads).
4. Reamers	1. Describe the different types of reamers, their proper use and storage. 2. Demonstrate the use of various reamers for a specified project.
5. Pliers	1. Describe the different types of cutting pliers and their applications. 2. Demonstrate the material cutting limitation of pliers and the proper use and care of.
6. Twist Drills	1. Explain how twist drills are classified, reconditioned and selected for common drilling operations. 2. Describe twist drill nomenclature: (a) shank (b) flute (c) margin (d) dead centre, etc. 3. Demonstrate reconditioning procedures and precautions of drill bits. 4. Describe the relationship of lubricants to material to be drilled. 5. Recognize and describe common drilling faults and causes. 6. Demonstrate proper drilling techniques including drilling safety precautions: (a) drill speed (b) drill breakthrough
7. Taps and Dies	1. Describe the types and applications of taps: (a) taper, plug, bottoming 2. Be able to recognize thread type and thread characteristics: (a) pitch, crown, depth, etc. 3. Describe tap and die failures and remedies.

TOPIC	COURSE OBJECTIVES
	4. Describe the care and storage of taps and dies.
	5. Calculate tap drill sizes.
	6. Specify correct threading lubricants, procedures and precautions and importance of thread "fit".
8. Abrasives	1. Describe the types and grades of abrasives — the limitations and safe use of: (a) sheet (b) disc (c) grinding wheels (d) cut off wheels (e) grinding compounds (f) hone stones
G. Hand Tools (Miscellaneous)	**2 Hours**
1. Stud and Bolt Removers	1. Demonstrate the use of stud and bolt removers.
	2. Describe the procedures and precautions when using stud and bolt removers.
	3. Demonstrate the reconditioning of holes and the installation of: (a) heli-coils (b) LAP-Lok, etc.
2. Flaring and Swaging Tools	1. Describe the reasons and procedures for annealing copper tubing.
	2. Demonstrate single, double and SI flaring of steel tubing.
	3. Recognize copper, steel, plastic and brass tube fittings.
	4. Describe and demonstrate tubing repairs.
	5. Recognize tube and fitting sizes.
	6. Demonstrate the use and care of tube benders and swaging (swedging tools).
3. Tube Pinchers	1. Demonstrate the use, procedures and precautions of tube pinchers.
H. Fastening Devices	**3 Hours**
1. Types, Uses and Selection of: (a) bolts (b) nuts (c) capscrews (d) screws	1. Describe the types, functions, grades, sizing and threading standards of fasteners S.A.E., S.I. and metric including: (a) bolts — bolt head designs — bolt grade markings (b) nuts — plain — castellated — slotted — lock nuts (c) screws — machine screws and nuts — set screws (d) capscrews
	2. Explain the theory of torquing.
	3. Demonstrate the torquing patterns, procedures and precautions for a given project.
	4. Describe the procedure for removal of seized nuts and broken bolts.
2. Types and Uses of Washers	1. Describe the use and function of the following: (a) flat washers (b) lock washers (c) shakeproof washers

TOPIC	COURSE OBJECTIVES
3. Types and Uses of Keys and Pins: (a) woodruff (b) square (c) split pins (cotter) (d) tapered pins (e) tubular pins	1. Describe the use of pins for fastening and alignment, including: (a) cotter pin (b) dowel pin — plain — threaded 2. Identify and describe the types of keys used in the industry. 3. Describe the installation and removal procedures of keys including the use of special tools. 4. Describe the use of set screws with keys and keyways.
4. Types and Uses of Rivets	1. Describe the application of the types of automotive rivets used in the industry. 2. Demonstrate the installation and removal procedures of rivets.
5. Locking Rings	1. Describe the types, shapes and functions of locking rings. 2. Describe the use of special tools in the removal and replacement procedures of locking rings and the safety precautions. 3. Demonstrate the fitting of locking rings including the correct fits and groove clearances.
I. Occupational Health and Safety Regulations	**9 Hours**
1. Study of the Regulations	1. Learn the first aid regulations. 2. Be aware of general accident prevention regulations with emphasis on: (a) general safety precautions (b) housekeeping, personal protective equipment, clothing (c) respiratory protective equipment (d) confined space entry (e) electrical wiring and equipment (f) powerlines (g) compressed and liquid gas systems. (h) compressed air prohibition, lines and nozzles (i) refrigerants — hazards and safety precautions (j) grinding (k) use of safeguards (l) ladders (m) hoisting units — slings (n) over filling refrigerant and propane containers
2. Fire Prevention and Controls	1. Identify the types of fires and available extinguishers. 2. Define the critical areas in the industry. 3. Learn how to prevent fires and work in safety: (a) use of proper waste containers
3. Other Concerns	1. Outline emergency procedures — and how to obtain assistance for injured workman. 2. Know the procedure for obtaining first aid training and certification. 3. Describe the industrial health hazards: (a) fumes and skin contact with toxic substance (b) noise (c) eye protection (d) exhaust fumes—carbon monoxide
4. Tools, Etc. (a) power tools (b) batteries (c) impact tools	1. List the reasons for and importance of grounding electrical equipment. 2. Describe why electrical equipment be kept dry and free from loose material.

TOPIC	COURSE OBJECTIVES
(d) belts and fans (e) automatic start-stop system	3. Explain the importance of maintaining power tools, electrical cords and plugs. 4. Describe the hazards associated with the checking and charging of automotive type batteries. 5. Describe battery polarity including boosting procedures and precautions. 6. Describe and demonstrate safe work practices when using impact tools. 7. Describe the hazards and precautions of moving belts and fans.
SECTION TWO: SAFE USE OF OXY-ACETYLENE EQUIPMENT (FOR SOLDERING AND BRAZING)	**12 HOURS**
A. Gases	**2 Hours**
1. Oxygen 2. Acetylene 3. Propane	1. Explain the characteristics, composition, and recommended handling precautions of the common gases.
B. Cylinders and Fittings	**2 Hours**
	1. Identify the respective cylinders and fittings by colour, thread design and sizes. 2. Explain the design of the cylinders and how these are to be handled and stored.
C. Regulators and Hoses	**2 Hours**
	1. Describe the principle operation of regulators, their operating pressures, safety, maintenance and testing. 2. Identify and describe hoses as to: (a) colouring (b) threads (c) sizing standards 3. Describe the care and handling of hoses. 4. Describe the methods and precautions of detecting leaks in oxy-acetylene equipment.
D. The Oxy-Acetylene Torch	**3 Hours**
	1. List and identify the parts of a torch. 2. List and describe the functions of torch components including tip types and sizes. 3. Describe and demonstrate the correct lighting and extinguishing procedures, the types of flames available and use of each type for oxy-acetylene welding and cutting: (a) carburizing (b) neutral (c) oxiding 4. Demonstrate the care and storage of a torch and tips including cleaning methods. 5. Explain the following terms, causes and corrective procedures for: (a) backfires (b) flash backs (c) over heating (d) incorrect mixtures (e) shut-down

TOPIC	COURSE OBJECTIVES
E. Soldering and Brazing	**3 Hours**
	1. Describe the types and grades of solder and brazing materials used in refrigeration repairs, installations and fabricating including: (a) sil fos (b) silver brazing (c) stay brite (d) 95/5 (e) resin core
	2. Demonstrate torch soldering and brazing including: (a) joint preparation (b) fluxes (c) heat applications (d) clean up
SECTION THREE: **REFRIGERATION THEORY AND COMPONENTS**	**180 HOURS**
A. Refrigeration	**3 Hours**
1. History and Scope	1. Describe the evolution of refrigeration and its definition.
2. Transport Refrigeration	1. Explain the general background and function of refrigeration as it pertains to the industry-cooling and preservation.
B. Heat and Temperature	**4 Hours**
1. Definitions	1. Define heat and temperature.
2. Units	1. Define the types of heat including: (a) sensible (b) latent (c) specific (d) others
3. Temperature Scales	1. Identify the three fixed points for different temperature measuring scales. 2. List and interpret different temperature scales.
4. Temperature Conversions	1. Explain and use formulas on how temperatures are converted from one scale to another. 2. Calculate temperatures from celsius to fahrenheit and vice versa.
5. State of Matter	1. Define matter and describe its three basic states: (a) solid (b) liquid (c) gaseous 2. Describe matter as to gravity, density and saturation. 3. Describe the chemical and physical properties of air and water.
C. Methods of Heat Transfer	**2 Hours**
1. Principles and Laws	1. Describe principles and laws of heat transfer.
D. Gas Laws	**2 Hours**
1. Gas Laws (a) Boyle's Law (b) Charles' Law (c) Dalton's Law	1. Define the gas laws and explain their application to the industry. 2. Solve problems pertaining to the gas laws. 3. Describe equations of the gas laws.

TOPIC	COURSE OBJECTIVES
E. Work, Power and Energy (Imperial and Metric Measurements)	**4 Hours**
1. Force	1. Define force. 2. List the units of force.
2. Pressure	1. Define pressure (gauge and absolute). 2. List the units of pressure (imperial and metric). 3. Measure and calculate pressures using the necessary instruments. 4. Describe pressure effects on a liquid. 5. Calculate pressures using scales and scale conversions.
3. Work	1. Define the unit of work (Joule) (J).
4. Energy (a) kinetic (b) potential	1. Define the two kinds of energy. 2. Solve problems concerning energy.
5. Power	1. Define power. 2. Solve problems concerning power.
6. Efficiency	1. Define efficiency. 2. Describe its application to refrigeration: (a) volumetric efficiency (b) motor efficiency
7. Specific Gravity and Densities	1. Define specific gravity and density. 2. Relate each as it applies to a ratio of water or a gas.
F. Basic Refrigeration Cycle	**5 Hours**
1. Basic Cycle	1. Describe the operation of a basic cycle of a refrigeration system. 2. Identify the main components.
2. Mechanical Refrigeration Cycle	1. Identify with the aid of a diagram or unit all the main components in a mechanical refrigeration system. 2. Indicate their location and function. 3. Explain the cycle in detail including fundamentals of the system. 4. Describe the applied physics fundamental to the function of a refrigeration system including: (a) forms of energy (b) temperature and heat (c) units of measurement (d) work and power (e) methods of heat transfer (f) effect of heat, change of state
G. Refrigerants	**2 Hours**
1. Desirable Properties	1. Explain the purpose and desirable properties of a refrigerant.
2. Classifications	1. List the two most common refrigerants used in the industry and why the correct refrigerant must be used in a system.
3. Characteristics	1. Explain the characteristics of the refrigerants common in the industry.
4. Hazards and Safety Precautions	1. Describe hazards and safety precautions when handling and working with refrigerants.
5. Net Refrigeration Effect	1. Define "net refrigeration effect". 2. Manipulate formulae to solve the problems given in worksheets.

TOPIC	COURSE OBJECTIVES
6. Refrigerant Tables	1. Read and interpret refrigerant tables and solve related problems. 2. With the aid of formulas and charts, determine the pressure-temperature relationship of the various refrigerants common in the industry. 3. Perform pressure and temperature calculations in Imperial and S.I. units and convert calculations between the two systems.
7. Leak Detection	1. List and demonstrate 3 methods of leak detection. 2. Explain the use of nitrogen and R12 for leak testing.
8. Termal Quantities and Transfers	1. Describe thermal quantities and transfers of R12.
9. Heat Content	1. Compute heat content of refrigerant at various points in a system.
10. Superheat	1. Define superheat and be able to identify its location in a cycle.
11. Sub-cooling	1. Describe the purpose of sub-cooling a refrigerant. 2. Describe how sub-cooling is accomplished in a system.
12. Forms of Heat Transfer (a) conduction (b) convection (c) radiation	1. Define the three basic forms of heat transfer. 2. Describe heat flow by each method.
H. Pressure Enthalpy Diagrams	**4 Hours**
1. The Chart 2. Relating the Chart to the Mechanical Cycle 3. System Calculations 4. Analysis of System Operation by us of P.E. Diagrams	1. Describe the meaning of the various lines, curves and numbers found on enthalpy charts and indicate their function. 2. With the aid of charts and information supplied, plot a complete cycle on an enthalpy chart and list all the information derived from the plot. 3. With test equipment and a unit available obtain all necessary information to plot and calculate for a unit evaluation on an enthalpy chart.
I. Air Conditioning Theory	**4 Hours**
1. Psychrometry 2. The Pyschrometric Chart and Its Uses 3. Air and Apparatus Dewpoints, Sensible Heat Factor 4. Use of Psychrometric Chart in System Analysis	1. Define psychrometry. 2. Describe the meaning of the various lines, curves and numbers found on psychrometric charts and indicate their function and uses. 3. Understand the properties of air, apparatus dewpoints and sensible heat factor in relation to the design and operating systems for practical valve. 4. Demonstrate the procedure to plot and obtain information from a psychrometric chart when only two atmospheric conditions are known. 5. Demonstrate the procedure to evaluate the performance of a unit by the psychrometric method.
J. Compressors	**4 Hours**
	1. Identify the types and principles of operation of compressors used in the industry. 2. Describe the valve arrangements and action in compressors. 3. List methods of capacity control and explain the purpose of the compressor capacity control devices. 4. Identify the parts of a compressor. 5. Trace refrigerant flow through a compressor. 6. Describe a compressor's lubrication system. 7. Describe capacity and calculate capacity of a compressor.

TOPIC	COURSE OBJECTIVES
K. Basic Design Calculations	**4 Hours**
1. Compression Ratio 2. Net Refrigeration Effect 3. Required Weight of Refrigerant 4. Volume of Vapour to be Pumped 5. Servicing	1. Correctly explain the related compressor and design terminology. 2. Solve problems involving the related terminology.
L. Compressor Oil	**3 Hours**
	1. Explain the purpose of compressor oil. 2. List three viscosities of oil used in the industry. 3. Describe the proper handling and storage of compressor oil. 4. Describe the oil condition when given an oil color. 5. Describe types of compressor oil: (a) synthetic base (b) petroleum base 6. Perform an oil acidity test and describe the purpose of it.
M. Valves	**6 Hours**
1. Purpose 2. Types (a) 3 way (b) 4 way (c) solenoid (d) check valves	1. Describe the purpose of refrigerant check and control valves used in a system. 2. List three techniques used to control refrigerant flow in a system. 3. Trace the refrigerant flow through a check valve. 4. Describe operating principles of the valves listed. 5. Test and replace faulty valves in a system.
N. Condenser	**2 Hours**
	1. Explain the purpose of the condenser. 2. Describe the construction of condensers. 3. Describe the purpose and function of various types of condensers used in the refrigeration systems including: (a) air cooled condensers (b) water cooled condensers (c) evaporative condensers (d) heat exchangers 4. Diagnose plugged or restricted condensers internally or externally. 5. Diagnose a leaking condenser check valve and faulty condenser pressure control solenoid SV-1. 6. Describe the purpose of condenser shutters. 7. Describe the operation of shutters. 8. Demonstrate adjustments as required on shutters.
O. Receivers	**4 Hours**
1. Construction	1. Describe construction of a receiver.
2. Function	1. List three functions of a receiver tank.
3. Receiver Valves (a) purpose (b) construction	1. Describe the purpose of the receiver valves. 2. Recognize the difference in receiver outlet valve design. 3. Describe the construction of receiver valves. 4. Diagnose a faulty receiver by pass check valve.

TOPIC	COURSE OBJECTIVES
P. Drier-Filter	**2 Hours**
1. Construction	1. Describe the construction of a drier-filter.
2. Function	1. List three purposes of the drier.
3. Operation	1. Describe the operation of a drier and diagnose a faulty filter drier.
4. Installation and Location	1. Describe the installation procedure and location of a drier-filter in a system.
Q. Moisture Indicators	**1 Hour**
1. Purpose	1. Describe the purpose, construction and operation of a moisture indicator.
2. Construction	
3. Operation	
R. Heat Exchanger	**2 Hours**
1. Purpose	1. Explain the purpose of the heat exchanger.
2. Operation	1. Trace refrigerant vapour and liquid flow through a heat exchanger.
3. Construction	1. Recognize the construction of a heat exchanger.
4. Capacity	1. Explain how the heat exchanger improves the capacity of a unit.
5. Diagnosing	1. Diagnose a faulty heat exchanger.
S. Evaporator Refrigerant Flow Controls	**8 Hours**
1. Purpose	1. State the purpose for the controls.
2. Location	1. Locate the flow controls in a system.
3. Types (a) automatice expansion valves (b) thermal expansion valves (c) capillary tubes	1. Identify the type of control used in a system. 2. Explain the operation of each type.
4. Operation (a) internally equalizing (b) externally equalizing	1. Explain the operation of internally and externally equalized valves.
5. Thermal Bulbs	1. Recognize the purpose of specially charged thermal bulbs.
6. Effect of Superheat	1. State the purpose of superheat as it applies to the expansion valve. 2. Test expansion valve superheat.
7. Faulty Control Valve	1. Diagnose an incorrectly operating expansion valve: (a) flooding the evaporator (b) starving the evaporator
8. Sizing Expansion Valves	1. Determine the correct size of an expansion valve for a system and explain problems that develop if it is incorrectly sized.
T. Evaporator	**3 Hours**
1. Purpose	1. Explain the purpose of an evaporator.
2. Classification	1. List the different classifications of evaporators.
3. Construction	1. Recognize the construction of an evaporator.
4. Distributors	1. Explain how distributors are used to avoid excessive pressure drop in a system. 2. Diagnose a faulty evaporator coil or distributor tube.
5. Air Flow	1. Describe the air flow through an evaporator including design and use of fans.

TOPIC	COURSE OBJECTIVES
6. Evaporator Performance	1. Describe items that affect evaporator performance and how to correct same.
U. Accumulator	**2 Hours**
	1. Explain the purpose of an accumulator. 2. Explain the operation of an accumulator. 3. Recognize the methods used to provide heat for the accumulator. 4. Describe methods of oil return.
V. Vibration Absorbers	**2 Hours**
1. Vibration Absorbing Lines	1. Describe the purpose of vibrasorbers. 2. Recognize the construction of the suction and discharge. 3. Describe safety precautions when servicing and replacing a suction or discharge vibrasorber.
2. Vibration Pads and Springs	1. Describe the purpose of using vibration pads and springs.
W. Service Valves	**2 Hours**
	1. Explain the purpose of service valves. 2. Identify the types of service valves used: (a) schrader (b) stem 3. Describe the procedure required when using each type of service valve.
X. Suction Throttling Valves	**4 Hours**
1. Suction Throttling Valves (a) evaporator pressure regulator (b) crankcase pressure regulator (c) discharge pressure regulator (d) hot gas bypass valve	1. Explain the purpose of a suction throttling valve. 2. Locate the suction throttling valve in the refrigeration piping. 3. Identify the types of suction throttling valves. 4. Describe the construction and operation of the valves listed. 5. Test and explain the steps to follow in adjusting the suction pressure. 6. Diagnose and replace faulty suction throttling valves. 7. Service a suction throttling valve removed from the unit (Thermo-King).
Y. Safety Release Devices	**3 Hours**
	1. Explain the purpose of the pressure safety release valve. 2. Recognize the two types of pressure release devices used. (a) blow-off (b) fusible plugs
Z. Basic Thermostat Operation	**2 Hours**
	1. Describe the control functions of a basic thermostat. 2. Understand the terminlogy used with controls of a basic thermostat operation. 3. Understand the operating principles of one, two and three switch thermostats.

TOPIC	COURSE OBJECTIVES
AA. Refrigeration and Heating Cycles	**18 Hours**
1. Refrigeration and Heating Cycles	1. Understand the cooling and heating cycles of: (a) 3-way valve and pilot solenoid (b) solenoid cycle control system (c) 4-way valve and pilot solenoid (d) thermac 5 2. From a diagram provided, trace the refrigerant flow in the cooling and heating cycle of units using the above. 3. Test a 3-way valve and pilot solenoid for operation. 4. Service a 3-way valve removed from the unit. 5. Explain the steps to follow in servicing a 3-way valve installed in the unit. 6. Test cycle control solenoids. 7. Service a cycle control solenoid removed from the unit. 8. Explain the steps to follow in servicing a cycle control valve installed in the unit. 9. Demonstrate master check procedures to evaluate unit condition.
BB. Safety Switches	**4 Hours**
1. Safety switches	1. Describe the purpose of safety switches. 2. Understand the operation of safety switches. 3. Be able to locate the following: (a) high pressure cutout (b) high engine temperature (c) low engine oil pressure (d) low compressor oil pressure (e) low pressure cut-outs (f) high condenser temperature (g) electrical overloads (i) generator (P.M.) (ii) fan motors 4. Understand the basic safety circuits to aid in diagnosing an engine shutdown.
CC. Test Instruments	**8 Hours**
1. Test instruments (a) hydrometers (b) thermometers (c) hygrometers (d) fluid flow meters (e) gaseous flow meters (f) gauge manifolds (g) charging apparatus (h) pressure and vacuum gauges	1. Using the correct terminology, identify and explain the function of the various measuring tools and test equipment common to the industry. 2. Demonstrate the correct methods of using the various measuring tools to the desired degree of accuracy, in both Imperial and metric common to the industry. 3. Demonstrate the correct method of using and interpreting the various testing and measuring equipment common in the industry. 4. Explain the correct procedures for the care, handling and storage of the various measuring and testing equipment common to the industry.
DD. Leak Testing	**2 Hours**
1. Leak Detection (a) halide torch (b) electronic (c) bubble test	1. Demonstrate the 3 methods of leak detection and correct any leaks as necessary.
2. Nitrogen and R12	1. Demonstrate the use of nitrogen and R12 for leak detection.

TOPIC	COURSE OBJECTIVES
EE. Moisture in a System and Its Effects	**6 Hours**
1. Moisture in a System (a) rust (b) sludge (c) acid formation (d) freezing in orfices	1. Explain the problems that can develop due to water contamination.
2. Removing Moisture from a System (a) evacuation (b) driers (c) compressor oil change (d) nitrogen	1. Demonstrate and describe procedures used to remove moisture from a system.
3. Cleaning a Severely Contaminated System (a) scrubbers (b) R11 flush (c) compressor oil change (d) nitrogen purge	1. Demonstrate and describe steps required for cleaning a severely contaminated system.
4. Hygroscopic Conditions and Materials	1. Explain the term "hygroscopic" and what effect it has on a refrigeration system.
FF. System Recharging	**10 Hours**
1. Procedure (a) liquid (b) vapour (c) partial charge	1. Demonstrate and list the 6 steps to charge a system. 2. Explain the purpose and operation involved in each step.
2. Safety Precautions (a) overcharge (b) refrigerant type	1. Use the correct refrigerant type and take precautions not to overcharge a system.
GG. Trailer Insulation and Seals	**2 Hours**
1. Purpose	1. Describe the purpose of insulation and seals.
2. Characteristics	1. Understand insulation characteristics. 2. Explain the need of insulation as it applies to the industry.
3. Air Infiltration	1. Understand the need for control of air infiltration of the refrigerated unit.
HH. Trailer Loading	**2 Hours**
1. Loading Techniques	1. Recognize the need for correct trailer loading.
2. Air Circulation	1. Understand the need for proper air circulation.
3. Bulkheads	1. Understand the need of bulkheads for multi-temperature hauling.
4. Product Temperature On Loading	1. Indentify product temperature when loading, heat removal and temperature stabilization for various temperature and load conditions.
II. Food Preservation	**4 Hours**
1. Principles and Methods	1. Describe the principles and methods of food preservation.
2. Cool Storage	1. State the methods, conditions and precautions necessary to provide food preservation under cool storage and transit conditions.
3. Freezing	1. Describe freezing methods. 2. Understand the importance of stable temperatures.
4. Fresh Meat Storage	1. Describe storage conditions of fresh meat including: (a) temperature requirements (b) shrinkage and humidity (c) aging and tenderizing (d) importance of sanitation

TOPIC	COURSE OBJECTIVES
5. Dairy Product Refrigeration	1. Be familiar with storage temperatures for dairy products.
6. Tables and Charts	1. Use product temperature charts to state the various transit and storage temperatures required for various products. 2. Use charts and forms to calculate heat removal in B.T.U./H and time required for the precooling, heat removal and temperature stabilization for various temperature and load conditions.
7. Trailer Cleanliness	1. Demonstrate trailer cleanliness and know the importance of sanitation.
JJ. Refrigeration Load Calculations	**8 Hours**
1. Review of Heat Transfer	1. Demonstrate knowledge regarding heat transfer.
2. Wall Gain (a) conductivity factor (b) overall conductance (c) transmission factors (d) colour	1. Identify and calculate wall gain with the factors listed. 2. Use various manufacturers' forms for load estimating.
3. Infiltration Loads	1. Identify and calculate infiltration loads.
4. Product Loads	1. Identify and calculate product loads: (a) sensible (b) latent (c) heat of respiration
5. Total Load and Safety Factor	1. Calculate the total load of a unit including a load safety factor.
KK. Multiplex Systems and Accessories	**12 Hours**
1. Multiple Evaporator Systems	1. Identify and describe the operating principles and applications of multiple evaporator systems for: (a) single temperature (b) dual temperature 2. Explain the fundamental differences between single and multiple-evaporator systems. 3. Identify the evaporator assembly accessories and establish the fundamentals of operation of each: (a) metering devices (b) evaporator pressure regulators (c) distributors
2. Multiple Compressor Systems	1. Identify and describe the operating principles and applications. 2. Establish factors influencing compressor selection for: (a) low temperature (b) medium temperature (c) high temperature 3. Explain the differences between single and multiple compressor systems.
LL. Unit Service	**20 Hours**
1. Preventive Maintenance (a) engine (i) filters —air —fuel —oil (ii) leaks —coolant —oil —fuel —air	1. Perform a regular maintenance schedule for engine filters. 2. Diagnose and correct engine leaks as necessary. 3. Inspect and maintain component security. 4. Adjust and set engine R.P.M. to manufacturer's specifications. 5. Locate, diagnose and report any unusual engine noises or conditions. 6. Inspect, test and service batteries and connections. 7. Inspect, test and maintain charging and starting circuits. 8. Inspect and correct faulty indicator lights as necessary.

TOPIC	COURSE OBJECTIVES
(iii) component security (iv) engine R.P.M. (v) unusual noises or conditions (b) electrical (i) battery (ii) charging circuit (iii) starting circuit (iv) lights (v) thermostats (c) refrigeration equipment (i) visible leaks (ii) refrigerant charge (iii) compressor condition (d) bearings (fan shafts) (e) idlers	9. Inspect and replace faulty thermostats. 10. Diagnose and correct any visible refrigeration equipment leaks. 11. Inspect the refrigerant charge and correct as necessary. 12. Inspect and report on any abnormal compressor condition. 13. Identify types of bearings used on fan shafts. 14. Establish maintenance procedures for bearings. 15. Demonstrate proper removal and replacement procedures for bearings. 16. Describe the function of idlers. 17. Identify and establish maintenance procedures for idlers. 18. Demonstrate proper removal and replacement procedures for idlers.

SECOND PERIOD TECHNICAL TRAINING
TRANSPORT REFRIGERATION MECHANIC
COURSE OUTLINE

SECTION ONE: **REFRIGERATION REVIEW** **30 HOURS**

TOPIC	COURSE OBJECTIVES
	Upon successful completion of each section the apprentice should be able to:
A. Review of Basic Systems	**30 Hours**
1. Principles of refrigeration	1. Describe the basic principles of refrigeration learned in first period.
2. Mechanical Refrigeration System	1. Explain the basic operation of a mechanical refrigeration system.
3. Refrigeration Components	1. Locate with the aid of a diagram or a running unit the four (4) main components common to all transport refrigeration systems. 2. Name the components used in the high and low pressure side of the system.
4. Controls	1. List and explain the operating principles of: (a) 3 way control (b) 4 way control (c) solenoid
5. Master check procedures	1. Demonstrate master check procedures to evaluate unit condition.
6. Unit condition	1. Demonstrate procedures to diagnose and evaluate unit condition.

SECTION TWO: **ELECTRICAL THEORY AND RELATED MATHEMATICS** **210 HOURS**

A. Direct Current	**30 Hours**
1. Structure of Matter 2. Electron Theory	1. Explain the fundamental relationship between the structure of the atom and the flow of electrons.
3. Electrical Units	1. Define quantity express symbols and units of measurement for the following electrical terms: (a) Volts (b) Amperes (c) Ohms (d) Watts (e) Watthours (f) Coulombs (g) Joules
4. Ohm's Law	1. Describe the relationship of voltage, current and resistance in an electric circuit. 2. Solve problems using Ohm's Law. 3. Connect circuits and make voltage, current and resistance measurements to verify Ohm's Law.
5. Electrical Circuits (a) series (b) parallel (c) series parallel	1. Analyze and explain series, parallel and series-parallel circuits and identify their applications. 2. Connect and take measurements of series and parallel circuits using schematic and wiring diagrams to verify Ohm's Law.
6. Kirchoff's Laws	1. Define Kirchoff's Laws. 2. Apply Kirchoff's current and voltage laws to a circuit.
7. Line Loss and Voltage Drops	1. Define and measure line loss and voltage drop in a circuit.
8. Conductors	1. Define conductor with reference to electricity. 2. Define resistivity.

TOPIC	COURSE OBJECTIVES
	3. Explain factors which affect the resistance of conductors.
9. Insulators	1. Define insulators with reference to electricity.
10. Prefixes (a) mega (b) kilo (c) milli (d) micro	1. Define the prefixes listed.
11. Electrical Test and Measuring Devices	1. Describe the proper care and safety precaution for ammeters, ohmmeters and voltmeters. 2. Demonstrate accurate measurements using a voltmeter, ohmmeter and ammeter. 3. Demonstrate proper scale selection and wire connections for voltmeters, ammeters and ohmmeters.
12. Faults (a) opens (b) shorts (c) grounds	1. When provided with a fault, diagnose the problem utilizing wiring diagrams and test equipment.
13. Heat Dissipation	1. Describe the importance of heat dissipation in electrical circuits.
14. Magnetism (a) magnetic fields and lines of force (b) magnetic attraction and repulsion (c) electromagnetic induction (d) self-induction	1. Describe the characteristics of magnetic lines of force. 2. State the laws of magnetic attraction and repulsion. 3. Describe the field around a current carrying conductor. 4. Describe electromagnetism. 5. Describe the self-induction in a coil.
15. Generations of electromotive force	1. Understand the methods used to generate AC and DC. 2. Describe the relationship between cycles, poles and frequency.
B. Electrically Operated Units	**55 Hours**
1. Battery	1. Describe battery: (a) construction in detail (b) sizes and capacities (c) handling and safety (d) maintenance and testing (e) charging procedures and precautions (f) multiple battery circuits
2. Switches (a) mechanical (hand operated) (b) micro (c) solenoids and relays	1. Describe the principles of operation and uses for the types of switches listed.
3. Solenoids (a) pull (b) rotary	1. Describe the operation and location of solenoids: (a) switch operating (b) valve operating (c) door operating (d) engine controls
4. Glow plugs	1. Explain the operation of glow plugs.
5. Safety Switches (a) pressure control (i) high refrigerant pressure cutout (ii) refrigerant pressure regulator HP2 (iii) low refrigerant pressure cutout	1. Recognize the switches location in the electrical circuitry of the standard components. 2. Describe the construction and function of the safety switches. 3. Perform adjustments on the switches as necessary.

TOPIC	COURSE OBJECTIVES
(iv) low engine oil pressure cutout (v) low compressor oil pressure cutout (b) temperature control (i) high engine temperature (ii) low engine temperature (c) electrical (i) thermal overload — manual reset — automatic reset	
6. Temperature Sensors (a) thermistor (b) bimetal (c) pyrometer (thermal couple)	1. Explain the function of a thermistor. 2. Locate the temperature sensors in the electrical circuitry. 3. Describe the construction of the sensors. 4. Demonstrate adjustments to the sensors.
7. Miscellaneous sensors (a) low fuel shutdown (b) low engine coolant shutdown	1. Describe the function and location of the sensors listed. 2. Identify the circuits the sensors are in.
8. Relays-Contactors	1. Describe the function of a relay-contactor. 2. Recognize their location (uses) in the electrical circuitry.
9. Thermostats (a) mechanical — 1 switch (b) mechanical — 4 switch (c) solid state (d) indicating controller (e) recording controllers	1. Describe the location, circuit, and construction of the thermostats. 2. Perform adjustments to the thermostats. 3. Describe the functions of the controllers.
10. Defrost Circuit Initiators (a) manual (b) air pressure differential (c) defrost timer (i) mechanical (ii) electrical (iii) electro-mechanical (d) air temperature defrost control	1. Describe the function of the defrost circuit initiators. 2. Recognize their location in the electrical circuitry. 3. Describe their construction. 4. Perform adjustments as necessary on the defrost circuit initiators.
11. Semi-conductors (a) diodes (b) transistors	1. Identify and locate diodes and transistors (uses) in the electrical circuitry of the standard components. 2. Describe the function of diodes and transistors. 3. Test and identify faulty diodes and transistors. 4. Explain different applications of diodes including: (a) as a switch (b) as a relay (c) rectifiers (i) single phase (ii) three phase
12. Capacitors	1. Describe the function, location and construction of a capacitor. 2. Identify the circuit containing capacitors.
13. Transformers (Appreciation Coverage) (a) basic construction (b) theory of operation (c) voltage ratio/current ratio/turns ratio relationship	1. Recognize the basic construction of a transformer. 2. Understand the theory of operation of transformers. 3. Describe and solve problems involving transformer voltage, turns and current ratio. 4. List the losses that occur in a transformer.

TOPIC	COURSE OBJECTIVES
(d) losses (e) cooling methods (f) ratings (g) efficiency (h) multiple secondary winding (i) reduced voltage taps (j) control and protection	5. Describe the various methods of cooling for distribution transformers and the liquid used. 6. Understand why transformers are rated in KVA rather than KW. 7. Understand why utilities accept 100% efficiency for transformer calculations. 8. Explain why a transformer has multiple secondary windings — differentiate between a step-up and step-down transformer. 9. Explain why a tap changer is required. 10. Describe how to set a tap changer to increase and decrease secondary voltage levels. 11. Describe the possible effects of operating a transformer at above its rated voltage. 12. Demonstrate safe working practices during all phases of practical assignments.
14. Meters and Indicator Lights (a) engine temperature gauge (b) engine oil pressure (c) ammeter (d) compressor suction gauge (e) box temperature thermometer (f) running time meter (g) indicator lights (h) out of range indicator	1. Describe the function, construction and location of the engine temperature gauge. 2. Describe the function, construction and location of the engine oil pressure gauge or indicator light. 3. Describe the function, location and construction of an ammeter. 4. Identify the circuit the ammeter is in. 5. Describe the function, location and construction of a compressor suction gauge. 6. Make adjustments to a compressor suction gauge. 7. Describe the function, location and construction of a box temperature thermometer. 8. Make adjustments to a box temperature thermometer. 9. Describe the function, location and construction of a running time meter.
15. Starting Motor (a) circuit (b) construction	1. Locate and test the starting motor circuit-voltage drop test. 2. Describe the starting motor circuit and construction.
C. Single-Phase A.C. Theory	**10 Hours**
1. A.C. Theory (a) sine waves (b) effective values (c) maximum of peak value (d) electrical degrees (e) cycles	1. Define instantaneous value. 2. Define effective value. 3. Define maximum or peak value. 4. Define: (a) phase (b) lead (c) cycle (d) angles in electrical degrees
2. Mechanical Generation of A.C. current (a) single phase (b) three phase	1. Describe the mechanical generation of A.C. current for single and three phase units.
3. A.C. circuits (a) single phase (b) three phase	1. Define a poly-phase electrical system. 2. Explain the generation of three phase voltages. 3. State the advantages for three phase systems over single phase systems.

TOPIC	COURSE OBJECTIVES
	4. Name the types of three phase connections.
	5. Define the term balanced three phase system.
	6. State the phase relationship for the 3 voltages in a three phase system.
4. Inductance and Inductive Reactance	1. Describe inductance and the factors which affect inductance.
	2. Describe induction and its effect.
	3. Describe the DC inductive effects.
	4. Describe the AC inductive effects.
	5. Define inductance and state its symbol.
	6. State the unit of measurement for inductance and its symbol.
	7. Define inductive reactance and state its symbol.
	8. State the unit of measurement for inductive reactance and its symbol.
5. Capacitance and Capacitive Reactance	1. Describe the construction and characteristics of an elementary capacitor.
	2. Describe capacitance and the factors which affect it.
	3. Describe capacitor types and applications.
	4. Explain AC capacitive effects.
	5. State the unit of measurement for the charge of a capacitor and give its symbol.
	6. Define dielectric strength.
	7. Define capacitance.
	8. State the unit measurement for capacitance.
	9. Define capacitive reactance.
	10. Give the symbol for capacitive reactance and state its unit of measurement.
	11. Explain the equation for capacitive reactance.
	12. State the phase relationship between voltage and current in a capacitive circuit.
	13. Understand the effects of capacitors hooked in series or parallel circuits.
6. Impedance	1. Define impedance.
	2. State the unit of measure for impedance.
	3. State the components of an impedance triangle.
7. A.C. (a) resistive circuit (b) inductive circuit (c) capacitive circuit	1. Define the circuits listed and explain the differences of each.
8. Power factor	1. Define "power factor".
	2. State why it is desirable to operate electrical systems at a high power factor.
	3. Identify the devices that can be used for power factor correction.
9. A.C. over D.C.	1. Describe the advantages of A.C. over D.C.
10. Balanced three phase system	1. Describe and know the importance of a balanced three phase system.
11. Unbalanced voltages-three phase system	1. Describe the effects of unbalanced voltages on a three phase system.

TOPIC	COURSE OBJECTIVES
D. Mechanical Generating Systems	**10 Hours**
1. Alternators (Automotive 12 V.D.C.)	1. Name the parts of an alternator. 2. List and explain the information found on the alternators nameplate. 3. Explain the principle of operation. 4. Demonstrate the ability to test and diagnose electrical and mechanical faults. 5. Demonstrate the overhaul procedures according to manufacturer's instructions.
2. Voltage and current regulation (a) mechanical regulation (b) solid state regulation	1. Identify different regulator types. 2. Explain regulation and factors affecting regulation. 3. Describe and demonstrate special testing procedures and precautions relating to regulators and circuits.
3. Alternators (High Voltage A.C.) (a) brushless three phase (b) methods of control (i) voltage (ii) current (iii) cycles	1. Describe principles of operation and function of three phase. 2. Recognize types and capacities of alternators. 3. Follow circuits utilizing diagrams and test equipment. 4. Understand terminology used. 5. Demonstrate inspection and testing procedures. 6. Explain methods of control and factors affecting control. 7. Overhaul an alternator according to manufacturer's procedures.
E. Electrical Power Supply Systems	**10 Hours**
1. Edison three wire system	1. Describe the concept of a three wire system.
2. Circuits-Protection and switching	1. Identify supply system protection from full load current rating for: (a) conductors (b) overcurrent (i) fuses (ii) breakers (c) overloads
3. Ground fault interpreters	1. Describe the function of a ground fault interpreter. 2. Identify the circuit and connections of a ground fault interpreter.
4. Plugs and receptacles (a) 2 prong old style (b) "U" ground (c) crow's foot (d) direct current (e) 230 volt tandem (f) 15 ampere, 50 volt, single phase (g) 20-30 ampere, 125-250 volt, single phase (h) 20 ampere, 250-480 volt, three phase (i) 30 ampere, 250-480 volt, three phase (j) 50 ampere, 250 volt, three phrase	1. Identify and understand the use of the plugs and receptacles listed.
5. Cable sizing (a) length vs. size of conductors for (i) horsepower rating (ii) voltage in use (iii) amperage draw (iv) length of run	1. Use electrical code tables for corrections when sizing cable. 2. Understand the voltage drop in sizing cables.

TOPIC	COURSE OBJECTIVES
6. Grounding of equipment	1. Recognize the proper use of portable tools and the importance of grounding equipment.
7. Electrical hazards	1. Identify electrical hazards, safeworking techniques and procedures when working with electrical circuits and rotating equipment, including: (a) proper use of tools (b) personal protective equipment (c) lockout and tagging procedures
8. Phase conversion (a) static converter (b) rotary multiphase converter (c) add-a-phase	1. Explain the principles of operation and connections. 2. Recognize the different types.
F. Ignition Systems	**10 Hours**
1. Major Electrical Components (a) recognition and function of: (i) spark plugs, reach and heat range (ii) ignition coils (iii) distributors and parts thereof (iv) ballast resistors	1. Recognize the parts listed and describe the function of each.
2. Ignition timing	1. Demonstrate the different methods of setting ignition timing. 2. Describe the results of incorrect timing setting.
3. Coil polarity	1. Check and determine correct coil polarity.
4. Condenser/coil	1. Describe the coil/condenser relationship.
5. Distributors	1. Demonstrate inspection procedures of the distributor and its parts. 2. Test, adjust and replace advance mechanisms. 3. Replace contact sets and describe procedures and precautions. 4. Inspect and determine distributor cap condition. 5. Determine other engine faults from distributor testing. 6. Demonstrate the ability to test and diagnose electrical and mechanical faults of an electronic ignition and repair as necessary.
6. Magnetos	1. Recognize styles and types of low and high tension magnetos. 2. Demonstrate testing and adjusting of magnetos. 3. Demonstrate replacing points, condensers and other parts. 4. Set timing to engine procedures. 5. Demonstrate ignition diagnosing procedures with diagnostic equipment. 6. Test and replace switches as necessary. 7. Demonstrate the ability to test and diagnose electrical and mechanical faults of a solid state magneto.
G. Electrical Circuits	**30 Hours**
1. Electrical Circuits (a) safety circuits (b) start circuit (c) high speed cool circuit (d) low speed cool circuit (e) low speed heat circuit (f) high speed heat circuit (g) defrost circuit (h) charging circuit	1. Recognize the following components and their location in the safety circuit: (a) high engine temperature (b) low engine oil pressure (c) high compressor discharge pressure (d) condenser fan motor overload (e) permanent magnet generator overload (f) low compressor oil pressure (g) low compressor suction pressure

TOPIC	COURSE OBJECTIVES
(i) automatic stop-start circuit	(h) fuses (i) circuit breakers (j) low fuel shutdown (k) low coolant shutdown 2. Recognize the components of the other circuits and their location within the circuit. 3. When provided with a fault, diagnose and repair the problem utilizing wiring diagrams and test equipment in the correct circuit including: (a) test continuity of a circuit using a test light (b) use a voltmeter for locating voltage drops (c) use an ohmmeter for testing resistance (d) use an ammeter for testing current draw (e) calibrate a United Electric 3-4 switch thermostat (f) calibrate a chart recorder (g) calibrate a defrost air switch (h) test an automatic defrost switch (i) test and calibrate a Carrier solid state thermostat (j) testing and calibrating a Thermo-King solid state thermostat (k) test a Motorola alternator
H. Electrical Motors	**25 Hours**
1. Single phase (a) split phase (b) capacitor start (c) permanent (capacitor run) (d) universal motor (e) soft start (f) dual voltage (g) repulsion	1. Understand the principles, characteristics and applications of single phase motors listed. 2. Demonstrate connections and draw diagrams for: (a) single and dual voltage (b) multiple speed (c) reversing (d) current and voltage starting relays
2. D.C. motors	3. Explain protective devices, including: (a) built in thermal (b) current relays (c) overload relays
3. Three phase motors	4. Demonstrate replacement of built-in thermal overload devices for single and dual voltage motors.
4. Motor controllers (a) manual (b) magnetic	5. Demonstrate a rotating magnetic field. 6. Explain rotor frequency, slip, poles and RPM relationship. 7. Explain regulation and efficiency. 8. Demonstrate the following conditions: (a) low voltage (b) high voltage (c) overloading (d) blocked ventilation (e) single phasing 9. Demonstrate the overhaul of a D.C. motor according to manufacturer's instructions. 10. Identify and interpret the information contained on a motor data plate. 11. Explain the application of relays to magnetic switches. 12. Explain the principles of a manual and magnetic switch. 13. Understand the operation of the components of a magnetic switch.

TOPIC	COURSE OBJECTIVES
I. Electrical Motor Trouble Shooting	**30 Hours**
1. Motors (a) will not start (b) motor noisy (c) high temperatures (d) hot bearings (e) wound rotor motor troubles	1. Diagnose the fault of motors that will not start utilizing systematic test procedures and test equipment. 2. Diagnose noisy motors and determine noise fault: (a) electrical (b) mechanical 3. Describe and recognize conditions that make a motor operate at above normal temperatures. 4. Correct conditions that make motors operate at higher than normal temperatures. 5. Relate the possible effects of over voltage and under voltage on motors. 6. Recognize and describe why bearings run hotter than normal including: (a) bushings (b) ball bearings 7. Describe the types of bearings, including: (a) friction (bushing) (b) anti-friction (i) regular (ii) angle 8. Demonstrate the installation of various bearings. 9. Check shafts before bearing installation for: (a) diameter (b) out of round (c) damage 10. Remove various bearings by using one or more of the following methods: (a) press removal (b) bearing splitter (c) inside puller 11. Diagnose rotor faults, including: (a) techniques of trouble shooting using growlers and single phase excitation (b) the importance of full load tests
2. Other Electrical Devices (a) tests performed	1. Perform tests on other electrical devices associated or related to motors.
(b) sequence of testing	2. Utilize a systematic sequence of testing.

THIRD PERIOD TECHNICAL TRAINING
TRANSPORT REFRIGERATION MECHANIC
COURSE OUTLINE

SECTION ONE: **GASOLINE AND DIESEL ENGINE THEORY, SERVICE AND REPAIR** **120 HOURS**

TOPIC	COURSE OBJECTIVES
	Upon successful completion of each section the apprentice should be able to:
A. Engines	**3 Hours**
1. Forward Material (a) stages of development (b) operating principles (c) classification (d) comparison of gas and diesel engines (e) engine types by manufacturer	1. Explain the stages of development of the internal combustion engine. 2. Explain the principles of operation in relation to: (a) torque (b) bore (c) stroke (d) engine displacement (e) compression ratio 3. Identify the different classifications of engines as to: (a) design of cylinder arrangement (b) different cooling methods (c) strokes per cycle (two and four) (d) valve arrangement and head design (e) induction method (f) type of fuel 4. Compare gasoline engines to diesel engines as to: (a) type of fuel (b) compression pressure and temperature (c) ignition of fuel charge 5. Describe the laws of machines as related to the internal combustion engine. 6. Recognize engine types by manufacturer including: (a) Izusu (b) Perkins (c) Kubota (d) Yanmar (e) Mercedes
B. Engine Components	**90 Hours**
1. Engine Blocks (a) materials (b) basic purpose (c) heat and friction (d) sleeves and liners (e) cylinder measurement (f) reconditioning cylinders and liners (g) journal alignment (h) inspection and testing	1. Identify the different materials used in cylinder blocks: (a) cast iron (b) aluminum 2. Explain the purpose of a cylinder block: (a) serves as a foundation for all engine parts 3. Explain the relationship of materials to heat and friction. 4. State the purpose of sleeves and liners. 5. State the methods of measuring a cylinder for: (a) taper (b) out of round (c) oversize 6. Explain the procedures employed in reconditioning cylinders and liners. 7. Explain procedures to check journal alignment. 8. Inspect and test a complete cylinder block for: (a) cracks (dye, magnetic particle, pressure test) (b) warpage

TOPIC	COURSE OBJECTIVES
	(c) wear (d) open or blocked passages
2. Cylinder Liners (a) types (b) remove and replace procedures (c) liner positioning	1. Identify different types of liners. 2. Demonstrate removal and replacement procedures. 3. Explain reasons for proper liner positioning.
3. Pistons and Piston Rings (a) materials (b) function (c) designs and construction of pistons (d) heat expansion and control (e) pistons to reciprocal motion (f) lubrication and cooling (g) measuring, fitting and oversizing (h) reconditioning (i) piston pins (j) function of piston rings (k) construction and material of rings (l) installation (m) gap and clearance (n) types of piston rings (o) designs of oil control rings	1. State the materials used in relation to expansion and heat control: (a) cast iron (b) aluminum 2. Describe the function of the piston: (a) transmit thrust (b) assist in sealing combustion (c) aid in creating turbulence (d) dissipate heat 3. Identify and state the function of special piston designs, construction and characteristics: (a) heat dam (b) cam ground piston (c) tapered piston (d) vertical slots (e) horizontal slots (f) slipper piston (g) knurling 4. Describe the relation of pistons to reciprocal motion. 5. Describe provisions used for lubrication and cooling. 6. Demonstrate proper measuring techniques with respect to: (a) accurate piston size (b) oversize determination (c) clearances 7. Describe reconditioning procedures including: (a) ring grooves (b) pin bores (c) cleaning 8. State the three pin retaining methods. 9. State a proper pin fit for a specified pin. 10. Describe the function of piston rings and location: (a) seal combustion and compression (b) control oil (c) transfer heat 11. State the construction of rings, material used, and the types of rings: (a) rectangular (b) tapered face (c) inside bevel (d) barrel face (e) step joint (f) angle joint (g) butt joint (h) cast iron (i) chrome plated (j) molybdenum (k) stainless steel 12. Install rings onto a piston properly observing all precautions including: (a) ring expanders (b) ring location

TOPIC	COURSE OBJECTIVES
	(c) lubrication 13. Measure and fit piston rings to piston and cylinder with reference to: (a) ring to land clearance (b) end gap (c) oversize cylinder 14. Identify and properly install segmented or one piece oil ring. 15. Demonstrate installation of the piston into the engine: (a) proper ring staggering (b) lubrication (c) ring compressor (d) bolt boots (e) rod torqued to shaft 16. Identify different designs of oil control piston rings.
4. Connecting Rods	1. Explain the function of the connecting rod. 2. State the material and process in manufacture of a connecting rod. 3. Identify the material used in connecting rod bushings. 4. Identify different types of rods by the type of pin. 5. State the pin clearance or interference fit in the eye of the rod. 6. State the materials used in bearing construction: (a) insert backing material (b) bearing materials (c) methods of applying bearing material to the backing 7. Identify methods of lubricating connecting rod bearings: (a) oil holes in inserts (b) oil passage drilled in rod (c) spurt hole in rod (d) connecting rod throw off oil 8. State seven (7) bearing insert characteristics: (a) conductivity (b) fatigue resistance (c) anti scuffing (d) conformability (e) imbedability (f) load carrying capacity (g) anti corrosion ability 9. Explain how a bearing is able to dissipate heat quickly. 10. Explain crush and spread and their purpose. 11. Demonstrate the procedure in resizing a connecting rod big end. 12. Demonstrate the procedure in straightening a rod: (a) bends (b) twists 13. Explain how a rod is balanced to the engine.
5. Crankshaft	1. Describe the function of the crankshaft. 2. Distinguish between the designs of different crankshafts for different engine designs. 3. Explain the relationship between firing orders. 4. State the different materials and method of crankshaft manufacture. 5. Describe the process used to balance a crankshaft: (a) internal balance (b) external balance

TOPIC	COURSE OBJECTIVES
	6. Name six major crankshaft parts: (a) main journal (b) rod journal (c) counterweight (d) web (e) check (f) oil slinger 7. Inspect and evaluate the condition of the shaft from the standard measurements: (a) journal size (b) out of round (c) taper (d) thrust bearing surfaces (e) fillet radius condition (f) straightness (g) crack detection 8. Identify different types and designs of crankshaft bearings. 9. Describe crankshaft lubrication provisions: (a) oil fed to rod throw from main journal 10. Demonstrate proper crankshaft installation, including: (a) cleanliness (b) lubrication (c) thrust bearing protection (d) plastigage (e) thrust main alignment 11. Measure a crankshaft for wear, taper, flatness and end play. 12. Understand the principle of magnafluxing.
6. Balance Dampers and Counterweights (a) function (b) design (c) service precautions	1. Describe the different means of balancing and relate the different balancing components: (a) flywheel (b) vibration dampers (c) rotating balance weights (d) crankshaft counterweights 2. Demonstrate proper removal and installation procedures of a harmonic balancer. 3. Recognize different designs of dampers and counterweights.
7. Camshaft (a) function (b) design and location (c) construction terminology (d) relationship to crankshaft (e) function as an auxiliary drive (f) bearings and lubrication (g) relationship to engine performance (h) measuring camshaft lobe and bearing wear (i) bearing removal and installation procedure	1. Describe the functions of the camshaft: (a) speed relationship to crankshaft (b) opens valves and determines closing rate 2. Contrast the design features of "in block" or "overhead" design. 3. Define and relate camshaft construction terminology (cam and lobe name parts). 4. Describe the camshaft relationship to a crankshaft. 5. Describe the use of the cam as a drive: (a) distributor (b) oil pump (c) fuel pump 6. Describe how the camshaft bearings and lobes are lubricated. 7. Describe camshaft relationship to engine performance. 8. Interpret a valve timing diagram: (a) lead (b) lag

TOPIC	COURSE OBJECTIVES
	(c) overlap (d) duration
	9. Recognize a worn cam lobe: (a) by visual inspection (b) by measurement
	10. Measure a camshaft journal for wear.
	11. Diagnose badly worn cam bearings by an oil pressure loss.
	12. Demonstrate the proper removal and installation of cam bearings.
8. Valve Train and Assemblies (a) types and designs (b) recognition, function and adjustment of: (i) valves (ii) guides (iii) rotators (iv) springs and retainers (v) lifters (vi) seals (c) relationship of valve design to engine design (d) relationship of valve design to heat dissipation (e) valve removal and reconditioning methods (f) major valve train repair methods, seats, guides, etc. (g) importance of valve spring tension and installation (h) refacing and reseating measurement precautions and methods (i) reconditioning rocker arms (j) lubrication provisions (k) relationship of valve timing to engine performance (l) compression release devices (i) principle of operation (ii) relationship to engine type	1. Describe the operation of several different valve trains: (a) overhead valves (b) overhead cam (c) dual overhead cam (awareness)
	2. Recognize the function and adjustment of the valves.
	3. Describe the function of guides and the different types of guides.
	4. Describe the function and action of a release type or positive type rotator.
	5. Recognize and describe the function of springs and retainers and spring adjustment.
	6. Describe the operation of a hydraulic lifter.
	7. State the interaction of the cam lobe with the lifter base and the design features built in.
	8. Test a hydraulic lifter.
	9. Measure to determine if a lifter is worn out.
	10. Describe the function of valve seals.
	11. Demonstrate installation of valve seals. (a) different lengths, inlet and exhaust (b) special protectors (c) positive seals (d) O ring types
	12. Describe the relationship of valve design to engine design.
	13. Describe the heat transfer method employed by the valve and state clearance differences between inlet and exhaust due to heat: (a) guide (b) valve lash
	14. Demonstrate valve removal and reconditioning methods: (a) proper use of a spring compressor (b) deburring the valve stem (c) stem wear (d) refacing (e) recondition stem end (f) inspection
	15. Describe and demonstrate the method of replacing the guide or the seat on a common center.
	16. Demonstrate proper installation of the valve.
	17. Demonstrate the proper positioning of the valve contact by grinding the seat.
	18. Perform a series of tests to determine if a valve spring is still good and know the importance of valve spring tension and proper installation.
	19. Describe how to recondition rocker arms.

TOPIC	COURSE OBJECTIVES
	20. Describe different methods of lubricating the valve train: (a) camshaft metering (b) restricted oil flow (c) push rod oiling
	21. Describe the relationship of valve timing to engine performance.
	22. Recognize engines that use a compression relief device and describe principles of operation.
9. Cylinder Head (a) types and designs (b) function (c) combustion chamber (see item 10 below) (d) relationship of design to heat and warpage (e) construction characteristics (f) removal procedures and precautions (g) inspection and testing (i) cracks, warpage, stoppages (h) assembly and installation procedures and precautions (i) reconditioning procedures	1. State the function of a cylinder head.
	2. Recognize the materials a head is made of: (a) cast iron (b) aluminum
	3. State the purpose in different combustion chamber designs.
	4. Discuss construction characteristics in cylinder head design: (a) coolant passages (b) coolant nozzels (c) inlet and exhaust ports
	5. Demonstrate removal procedures and precautions: (a) engine cool (b) properly drained (c) loosening sequence (d) proper storage
	6. Demonstrate proper testing procedure for head: (a) cracks (i) visual inspection (ii) magnetic particle (iii) dye check (iv) pressure check (b) warpage (i) straight edge (c) stoppages (d) damage to combustion chambers
	7. Recognize the reason for valve failure: (a) worn valve guide (b) fatigue failure (c) heat failure (d) erosion (e) preignition (f) insufficient tappet clearance (g) deposit on seat (h) valve seat distortion
	8. Properly take measurements pertaining to the following: (a) inside guide diameter (b) guide protrusion (c) diameter of valve stem (d) width of valve seat (e) margin width
	9. Repair a worn valve guide: (a) core the guide (b) knurl and ream (c) ream to oversize (d) sleeve with bronze
	10. Describe the proper removal and installation of valve seat inserts.
	11. Properly assemble the cylinder head with reference to: (a) cleaning of cuttings and grindings

TOPIC	COURSE OBJECTIVES
	(b) lubrication (c) correct installation of valves (d) correct installation of stem seals 12. Properly install the head gasket with regard for: (a) front and top of gasket (b) gasket positioning (c) use of a sealer (d) block and head surface condition 13. Torque the head in the proper sequence and stages.
10. Combustion Chambers (a) types and designs, recognition and function of: (i) open (ii) precombustion (b) applications (c) relative terminologies (d) remove, inspect and replacement of pre combustion chambers	1. State the purpose of the combustion chamber. 2. Recognize and state the function of: (a) open combustion chamber (b) pre combustion chamber (c) energy cell 3. Describe the application of: (a) open combustion chamber (b) pre combustion chamber (c) energy cell 4. Demonstrate removal and installation techniques involved with: (a) energy cells (b) pre combustion chambers
C. Engine Systems	**5 Hours**
1. Induction Systems (a) naturally aspirated (b) supercharged (appreciation coverage only) (c) air cleaners	1. Recognize a naturally aspirated engine. 2. Describe the function of the intake manifold. 3. Describe different styles of intake manifolds with regard to: (a) engine design (b) performance 4. Recognize the relationship of air flow to manifold design. 5. Demonstrate installation procedures of a manifold. 6. Diagnose an engine problem resulting from a leak in the induction system. 7. Recognize the types and designs of turbo chargers: (a) positive displacement (b) centrifugal displacement (c) piston type (d) turbine driven blowers 8. State the operating principles involved in turbo charging. 9. Recognize the precautions involved in servicing the turbo charger. 10. State the need for proper maintenance and describe what is necessary. 11. Describe the designs, styles and function of an air cleaner. 12. Describe the types and operation of each type: (a) centrifugal or inertia (b) dry (c) oil bath (d) impingement (including self cleaning types) 13. Demonstrate proper maintenance procedures for each air cleaner. 14. Describe styles and operation of precleaners. 15. Demonstrate proper maintenance procedures for precleaners.

TOPIC	COURSE OBJECTIVES
D. Lubrication Systems	**5 Hours**
1. Oil	1. Describe the functions of oil.
2. Grades and Types	1. Recognize the different grades and types of oil.
3. Lubricating Oil and Additives	1. Describe the use of lubricating oil and additives. 2. Define the following: (a) viscosity (b) viscosity index (c) pour point (d) inhibitors (e) detergents (f) dispersants (g) S.A.E. (h) A.P.I. 3. Describe characteristics of: (a) single viscosity (b) multi viscosity
4. Lubricating Systems	1. Describe the three basic lubrication systems: (a) splash (b) splash and pump (c) full pressure
5. Filters and Filter Circuits	1. Describe the full flow, partial flow and by-pass filter systems.
6. Servicing Filter Circuits	1. Demonstrate servicing of the full flow filter system.
7. Oil Pumps	1. Describe the designs and function of oil pumps. 2. Describe the operation of oil pumps: (a) rotor (b) gear 3. Test and diagnose oil pump failures and demonstrate reconditioning procedures. 4. Describe the operation of the lubrication system valving: (a) pressure relief valve (b) pressure regulator valve (c) pressure differential, filter bypass valve
8. Coolers	1. Describe the function, types and designs of oil coolers.
9. Pressure indicators	1. Describe the function and operation of pressure indicators.
10. Faulty Lubrication System	1. Diagnose the causes of: (a) low oil pressure (b) high oil pressure
11. Oil Analysis	1. Describe the use of an oil analysis as a diagnostic tool.
E. Cooling Systems	**5 Hours**
1. Liquid Cooling System (a) types and principles of operation (b) pressure and heat transfer (c) heat dissipation (d) systems demand and layout (e) control devices (f) radiators (g) hoses and clamps (h) coolant pumps (i) distributor tubes and nozzles (j) thermostats	1. Describe the functions of the cooling system: (a) control engine temperature (b) remove excess heat 2. Describe the physical principles involved in the operation of the liquid cooling system. 3. Relate the effect of pressure on the coolant with regard to boiling point. 4. Recognize heat transfer qualities of different metals. 5. Recognize cooling system components and explain the working sequence of a cooling system equipped with a thermatic fan, thermostat and shutters.

TOPIC	COURSE OBJECTIVES
(k) temperature and pressure indicators (l) shutters (m) vacuum and pressure (n) antifreeze (o) pressure caps and valves	6. Describe the function, material and designs of common radiators. 7. Describe the construction of radiator hoses and where they are used. 8. Inspect hoses and determine if replacement is necessary. 9. Explain the operating principle involved in the water pump. 10. Explain the procedure involved in testing and reconditioning a water pump with respect to: (a) impeller shaft (b) impeller (c) bearings (d) slinger (e) pulley hub (f) seal assembly 11. Describe the function of distribution tubes and nozzles. 12. Properly test a thermostat and describe designs and functions. 13. Describe the operation and testing of temperature and pressure indicators. 14. Describe designs and functions of shutters. 15. Demonstrate testing and adjusting shutters. 16. Describe the relation of vacuum and pressure to a cooling system operation. 17. Explain the function of coolant in the cooling system. 18. Explain the properties of different coolants: (a) water (with inhibitors) (b) alcohol base antifreeze (c) glycol base antifreeze (d) mixture strength 19. Describe the effect of a pressure cap on the system. 20. Test a pressure cap and determine if O.K. 21. Demonstrate the proper procedure for reverse flushing the: (a) engine (b) radiator (c) heater
2. Air Cooling Systems (a) operation (b) thermostats (c) limitations	1. Describe the principle of operation employed in the air cooling system. 2. Compare and contrast the air cooling and liquid cooling systems. 3. Describe the thermostat operation. 4. Know the limitations of an air cooled system.
3. Air Circulating Fans (a) fans and shrouds (b) fan drives	1. Describe basic fan blade design: (a) off set blades (b) variable pitch 2. Explain the function of the radiator shroud and precautions necessary for proper operation. 3. Describe the purposes for variable speed or intermittent fan operation: (a) thermo viscous (b) fluid drive

TOPIC	COURSE OBJECTIVES
	(c) electric fans 4. Test and adjust fan drives including: (a) strobe test 5. Describe and demonstrate reconditioning procedures.
F. Ventilation Systems	**2 Hours**
	1. Describe the operation of the ventilation systems. 2. Describe the purpose and necessity of the crankcase ventilation valve. 3. State the necessity of the P.C.V. system with regard to: (a) pollution (b) engine operation (c) fuel-air ratio 4. Test and diagnose a P.C.V. system problem.
G. Exhaust Systems	**2 Hours**
	1. Describe the function of the exhaust system. 2. Note the desired design characteristics and relate these to engine performance. 3. Recognize the use of mufflers and resonators in the system. 4. Demonstrate proper removal and installation procedures. 5. Recognize the need for insulators, isolators, and expansion devices as part of the installation. 6. Explain and demonstrate the need for venting the exhaust system to the outside. 7. Test engine exhaust back pressure. 8. Test exhaust temperature with a pyrometer.
H. Starting (Cranking) Systems	**5 Hours**
1. Basic Requirements	1. Describe the basic requirements of a starting (cranking) system.
2. Basic Function	1. Explain the basic function of a starting (cranking) system.
3. Starting Motors (a) types and designs (b) principles of operation (c) circuitry variations (d) identification and function of parts (e) diagnosis and testing routines (f) remove and replace procedures (g) service and repair limitations	1. Identify the types and designs of starter motors. 2. Explain the operating principles of a simple D.C. series starting motor. 3. Identify and interpret circuitry variations in different designs of starting motors. 4. Identify and understand the function of all starting motor parts. 5. Diagnose problems with a starter load test. 6. Test an assembled starting motor. 7. Diagnose the malfunctions from the test results. 8. Test a disassembled starter motor. 9. Diagnose and correct the faults found in the tests.
4. Cranking Motor Drives (a) types and designs (b) basic function of drive units (c) principles of operation (d) inspection, cleaning and testing drives	1. Identify the types and designs of starter drives (in service). 2. Describe the basic function and principles of operation. 3. Inspect, clean and test drives.

TOPIC	COURSE OBJECTIVES
5. Cranking Motor Control Systems (a) types and designs (b) functional features of each (c) test and diagnosis procedures (d) repair and replace limitations (e) constructional details of control systems (f) safety provisions	1. Identify and describe the types and designs. 2. Describe the functional features of each. 3. Demonstrate testing and diagnosing procedures. 4. Demonstrate repairs and replacement of parts. 5. Draw a schematic of starter controls and explain their operation. 6. Explain safety devices on starting circuits. 7. Describe series-parallel switching on 24V starting circuits.
I. Starting Aids	**1 Hour**
1. Basic Function	1. Describe the basic functions of starting aids including: (a) preheating the intake air
2. Starting Fluids	1. Understand the chemical characteristics of starter fluids. 2. Describe the function, use and precautions when using starting fluid.
J. Emission Control	**2 Hours**
	1. State the basic problems with and the control of: (a) oxides of nitrogen (b) carbon monoxide (c) hydrocarbons (d) particulants (e) leads 2. State the purpose of: (a) catalytic converter (b) E.G.R. system (c) P.C.V. system (d) air injection
SECTION TWO: **DIESEL FUEL INJECTION SYSTEMS**	**45 Hours**
A. Fuels, Unit Tanks, Bulk Storage, Filters, Water Traps, Breathers, Etc.	**3 Hours**
1. Fuels	1. Interpret fuel specifications.
2. Additives	1. List the common additives in diesel and their purpose.
3. Tanks	1. Describe the construction requirements of tanks. 2. Demonstrate tank mounting methods and describe necessary precautions.
4. Other Items	1. Recognize and describe the function of: (a) screens (b) check valves (c) lines (d) breathers (e) selector valves
B. Transfer Pumps	**1 Hour**
1. Transfer Pumps	1. Identify the styles and types of transfer pumps. 2. Describe their function and principles of operation. 3. Recognize the characteristics of construction. 4. Demonstrate diagnosing and testing methods. 5. Demonstrate removal and installation procedures and precautions.

TOPIC	COURSE OBJECTIVES
C. Fuel Filters	**1 Hour**
1. Fuel Filters	1. Describe the basic function and limitations of fuel filters. 2. List the types of filters and their applications. 3. Describe the construction of each type of fuel filter and give the location in a fuel system of each type. 4. Describe test methods and interpretation of the fuel flow. 5. Demonstrate service procedures and precautions. 6. Demonstrate filling and bleeding procedures.
D. The Basic Fuel Injection System	**3 Hours**
1. Fuel Injection System	1. Describe the demand requirements of an injection system. 2. Describe the basic layout of an injection system including: (a) tank (b) lines (c) pump (d) nozzles 3. Recognize all components of a system and describe their function. 4. Describe the function and operation of an automatic timing advance.
E. Port and Helix Metering Systems	**1 Hour**
1. Port and Helix	1. Describe principle of operation. 2. Describe the basic characteristics of port and helix metering systems. 3. Describe construction of these systems. 4. Perform minor adjustments. 5. Recognize applications of these systems. 6. Demonstrate inspection and diagnosis procedures. 7. Recognize crankcase fuel dilution and correct causes.
F. Mechanical Injection Fuel Systems (Identification by Manufacturer)	**30 Hours**
1. Bosch, Bendix-Simms (In Line Port and Helix)	1. Identify each of these systems. 2. Recognize design variations and applications. 3. Demonstrate adjusting and timing procedures. 4. Describe and demonstrate removal and installation precautions. 5. Demonstrate inspection and diagnosis procedures for pumps. 6. Describe the function and operation of injection lines and injectors. 7. Demonstrate testing and adjusting injectors. 8. Demonstrate removal and replacement of injectors, describe procedures and precautions. 9. Demonstrate filling and bleeding procedures. 10. Describe lubrication provisions. 11. Demonstrate the sequence of system testing.
2. General Motors System (Appreciation Coverage Only)	1. Identify unit injectors. 2. Understand the principles of operation. 3. Recognize design variations and applications. 4. Demonstrate adjusting and timing procedures.

TOPIC	COURSE OBJECTIVES
	5. Demonstrate diagnosis, inspection and corrective procedures.
	6. Describe the function of the fuel transfer pump, supply and return lines.
	7. Describe the operation of and demonstrate testing of lines and transfer pump.
	8. Demonstrate service and installation procedures.
3. Roosamaster/C.A.V. System	1. Identify the types and designs.
	2. Describe the principles of operation.
	3. Describe design variations and applications.
	4. Demonstrate adjusting and timing procedures.
	5. Demonstrate diagnosis, inspection and corrective procedures of faults.
	6. Describe lubrication provisions.
	7. Identify injection lines and injector nozzles.
	8. Describe the operation, testing and adjusting procedures of injector nozzles.
	9. Demonstrate removal and replacement of nozzles and precautions.
	10. Demonstrate filling and bleeding procedures.
	11. Demonstrate a sequence of system testing.
G. Governors	**6 Hours**
	1. Recognize the different types and designs of governors: (a) mechanical
	2. Describe the function of a governor and limitations.
	3. Describe the principles of operation.
	4. Define governor terminology and its application (i.e. response, stability, sensitivity, droop, etc.)
	5. Describe inherent characteristics of specific types.
	6. Diagnose problems in terms of type and function.
	7. Demonstrate and describe adjustment limitations to each type.
	8. Describe and ensure adequate lubrication provisions for a governor.
	9. Make minor repairs and adjustments.
SECTION THREE:	**GASOLINE AND PROPANE ENGINE EXTERNAL SYSTEMS** **15 HOURS**
A. Ignition Systems (Review of Second Period Material)	**6 Hours**
1. Ignition Systems (a) spark plugs, reach andheat range (b) ignition coils (c) distributors and parts thereof (d) ballast resistors	1. Recognize these major components and describe their functions.
2. Ignition Timing	1. Demonstrate methods and describe results of setting ignition timing.
3. Coil Polarity	1. Check and determine correct coil polarity.
4. Condenser/Coil Relationship	1. Describe the coil/condenser relationship.
5. Distributors	1. Demonstrate inspection procedures of the distributor and its parts.
	2. Test, adjust and replace advance mechanisms.

TOPIC	COURSE OBJECTIVES
	3. Replace contact sets and describe procedures and precautions.
	4. Inspect and determine distributor condition.
	5. Determine other engine faults from distributor testing.
	6. Demonstrate the ability to test and diagnose electrical and mechanical faults of an electronic ignition and repair as necessary.
6. Magnetos	1. Recognize styles and types of low and high tension magnetos.
	2. Demonstrate testing and adjusting of magnetos.
	3. Demonstrate replacing points, condensers and other parts.
	4. Set timing to engine procedures.
	5. Demonstrate ignition diagnosis procedures with diagnostic equipment.
	6. Test and replace switches as necessary.
	7. Demonstrate the ability to test and diagnose electrical and mechanical faults of a solid state magneto.
B. Gasoline Fuel Systems	**3 Hours**
1. Tanks	1. Describe the locations and arrangements of fuel tanks.
	2. Describe the unit detail in relationship to emission control.
	3. Demonstrate removal and replacement precautions.
	4. Demonstrate repair procedures and limitations.
2. Fuel Pumps	1. Identify the different types and designs of fuel pumps.
	2. Describe the function of a fuel pump.
	3. Describe performance limitations of a fuel pump.
	4. Measure fuel pump pressure and vacuum and compare with specifications.
	5. Measure fuel flow at engine idle and compare delivery and capacity minimums to specifications.
3. Lines and Filters	1. Recognize and identify the types and styles of fittings.
	2. List the types of fuel filters.
	3. Explain the purpose of fuel filters.
	4. Describe the construction of each type of fuel filter and give the location in a fuel system for each type.
	5. Identify the evaporation control system (ECS) and explain its purpose.
4. Carburetor (s)	1. Explain the function of a carburetor.
	2. Recognize and identify the types and designs in the trade.
	3. Describe the principles of operation.
	4. Describe the principles of atomization and vacuum applications.
	5. List and describe the carburetor relationship and design features to help reduce emissions.
	6. Identify the seven circuits in a modern carburetor and describe their function.
	7. Demonstrate diagnose procedures in locating and correcting carburetor faults.
	8. Test and adjust carburetors to manufacturers' specifications.

TOPIC	COURSE OBJECTIVES
C. Liquified Petroleum Gas Systems	**2 Hours**
1. Precautions	1. Demonstrate specific precautions in: (a) handling (b) storage (c) ultization
2. Storage Tanks	1. Describe principles of operation of a storage tank. 2. Describe where a storage tank for L.P.G. should be located and security precautions. 3. Describe the capacity and maximum filling level of a L.P.G. tank.
3. Pressure Regulators (First and Second)	1. Describe the function of regulators. 2. Describe the principle of operation. 3. Perform regulator adjustments and describe adjustment limitations. 4. Diagnose malfunctioning and faulty regulators. 5. Demonstrate servicing requirements as necessary.
4. Operation Of a L.P.G. System	1. Describe the principles of operation of an L.P.G. system.
5. Characteristics	1. List and describe distinctive characteristics of L.P.G.
6. Fuel Comparison	1. Describe energy comparison of L.P.G. with gasoline and diesel fuel.
7. Carburetors	1. Recognize and identify the types and designs of L.P.G. carburetors. 2. Describe the principles of operation. 3. Compare the circuitry of a L.P.G. carburetor to one of a gasoline carburetor. 4. List the engine modifications that are required to convert from gasoline to L.P.G. 5. Perform adjustments and recognize adjustment limits for L.P.G. carburetors. 6. Diagnose faults and correct the results of the diagnosis.
D. Engine Testing and Adjusting to Manufacturer's Specifications	**3 Hours**
1. Procedures	1. Describe and demonstrate preparation procedures. 2. Demonstrate start up procedures and precautions. 3. Demonstrate run-up and test procedures using all test equipment. 4. Recognize and interpret incorrect operating conditions (i.e. smoking, loss of power, low R.P.M.s, excessive noise, etc.) 5. Demonstrate corrective action and procedures for incorrect operation. 6. Demonstrate shutdown precautions after completion of tests and tune-up.
E. Special Conditions	**1 Hour**
1. Altitude	1. Describe the effect altitude has on engine tune and performance.
2. Weather Conditions	1. Describe the effect of severe weather conditions on engine running, starting and performance.
SECTION FOUR:	**REFRIGERANT COMPRESSORS** **15 HOURS**
A. Compressors	
	1. Identify the types of compressors used in the industry: (a) mechanically driven (b) semi-hermetic

TOPIC	COURSE OBJECTIVES
	2. Describe the function of the compressor in the system and its basic principles and general operation. 3. Describe the cooling and lubrication provisions for the types of compressors. 4. Perform an efficiency check and recognize and record all malfunctions. 5. Demonstrate proper diagnosis and testing procedures for malfunctions. 6. Demonstrate reconditioning procedures and precautions. 7. Calculate the displacement and capacities of compressors. 8. Identify direction of rotation for lubrication: (a) importance (b) valving 9. Describe the function of a compressor shaft seal. 10. Replace leaking compressor shaft seals.
SECTION FIVE:	**HEATERS** **25 HOURS**
A. Systems	
1. Catalytic Heaters (a) cargo propane (b) Elston (c) Flameless	1. Describe the operating principles of the heaters listed. 2. Describe safety precautions required when lighting, servicing and installing including: (a) lines and connections 3. Recognize and record all malfunctions.
2. Open Flame (a) open flame combustion (b) enclosed combustion	1. Describe the operating principles of the heaters listed. 2. Describe safety precautions required when lighting, servicing and installing including: (a) lines and connections 3. Recognize and record all malfunctions.
3. Gas/Diesel/Kerosene Heaters (Open Flame) (a) Espar (b) Wabasto (c) Benmar (d) Hunter (e) Stewart Warner	1. Identify the types of heaters listed. 2. Describe operating principles. 3. Describe safety precautions when lighting, servicing and installing including: (a) lines and connections
4. Engine Exhaust Heater (a) Astro	1. Describe the operating principles. 2. Demonstrate service and installation procedures including: (a) lines and connections
SECTION SIX:	**RECORDS AND REPORTS** **20 HOURS**
A. Value Of Business Systems	**20 Hours**
1. Records and Reports	1. Describe business and trade related practices involving: (a) shop calculations (b) estimating (c) inventories (d) business operations (e) warranty forms 2. Recognize the value of records and reports. 3. Write and know the importance of a properly written work order.
2. Preventive Maintenance Schedules	1. Establish and use preventive maintenance schedules. 2. Recognize and state the value of preventive maintenance schedules.

SUGGESTED REFERENCE MATERIALS

Up-to-date handouts are supplied for indentured apprentices taking training.

F.O.S. — Fasteners by John Deere

F.O.S. — Tools by John Deere

F.O.S. — Electrical Systems by John Deere

Occupational Health and Safety Act — Office Consolidation

Diesel and High Compression Gas Engines by E. J. Kates and W. E. Luck

TECHNICAL TRAINING SCHOOLS

The Transport Refrigeration Mechanic apprenticeship training program is offered by Alberta Manpower, Apprenticeship and Trade Certification. Staff and facilities for teaching the program are supplied by:

1. Southern Alberta Institute of Technology

LOCATION OF APPRENTICESHIP AND TRADE CERTIFICATION REGIONAL OFFICES

BONNYVILLE

CALGARY

EDMONTON

FORT McMURRAY

GRANDE PRAIRIE

HINTON

LETHBRIDGE

MEDICINE HAT

PEACE RIVER

RED DEER

VERMILION

GOVERNMENT OF THE PROVINCE OF ALBERTA

ALBERTA REGULATION 329/81

(Filed on September 2, 1981)

THE MANPOWER DEVELOPMENT ACT

MINISTERIAL ORDER

I, James D. Horsman, Minister of Advanced Education and Manpower, pursuant to sections 30(2) and 37(2) of The Manpower Development Act, make the Regulation in the attached Appendix, being the Transport Refrigeration Mechanic Regulation.

Dated at Edmonton, Alberta, August 2, 1981.

JAMES D. HORSMAN,
Minister of Advanced Education
and Manpower.

APPENDIX

THE MANPOWER DEVELOPMENT ACT

Transport Refrigeration Mechanic Trade Regulation

1(1) In this regulation

(a) "transport refrigeration mechanic" means a person engaged in the installation, repair, modification, overhaul or maintenance of equipment to supply and contain conditioned air in mobile units;

(b) "General Regulations" means the General Regulations under The Manpower Development Act, (Alta. Reg. 43/77);

(c) "trade" means the transport refrigeration mechanic trade.

(2) The definitions in the General Regulations apply in this regulation.

PART 1

APPRENTICESHIP AND TRADE TRAINING

2 A person is eligible to be an apprentice in the trade, if he satisfies the requirements of section 5 of the General Regulations and passes the entrance examination prescribed by the Board.

3(1) Subject to subsections (2), (3) and (4), a person engaged in the trade and who is a journeyman or employs a journeyman, may employ one apprentice and may employ one additional apprentice for each additional journeyman he employs.

(2) If the supply of journeymen in a location where an employer is carrying on business is insufficient to permit the employer to carry out his work commitments, the Director may authorize the employer to employ apprentices in addition to those permitted under subsection (1).

(3) The Director may authorize an employer to employ an apprentice in addition to those permitted under subsections (1) and (2) on a temporary basis, to train him in a branch of the trade not engaged in by the employer to whom he is apprenticed.

(4) For the purposes of subsections (1) and (2) an apprentice employed temporarily under subsection (3) shall not be considered to be an apprentice of his temporary employer.

4(1) The term of apprenticeship shall consist of 3 periods.

(2) Each period referred to in subsection (1) shall consist of not less than 1800 hours of employment exclusive of time spent attending the technical training courses prescribed by the Board.

(3) The Director may not under section 25(1) of the Act, reduce the term of apprenticeship to be served by an apprentice to less than one period of apprenticeship.

5 When a contract of apprenticeship is registered with the Director, he shall issue an official record book referred to in section 14 of the General Regulations to the apprentice.

6(1) An apprentice shall not advance to the next period until the Director has authorized him to do so by making an entry in the apprentice's official record book under subsection (2).

(2) The Director shall make an entry in the apprentice's official record book authorizing advancement to the next period, when the apprentice

(a) has completed the previous period of apprenticeship,

(b) has received in the opinion of the Director, a satisfactory report from

(i) his employer, and

(ii) the school at which he attended technical courses prescribed by the Board,

(c) has completed the tests and examinations prescribed by the Board, and

(d) has attained the passmarks prescribed by the Board in those tests and examinations referred to in clause (c).

7 The official record book of an apprentice shall be kept in the possession of his employer and, on termination of the employment of the apprentice, the employer shall present the completed book to him.

8(1) An employer shall pay wages to an apprentice that are not less than the following percentages of the prevailing wages paid to a journeyman:

(a) 60% in the first period;

(b) 75% in the 2nd period;

(c) 90% in the 3rd period.

(2) Notwithstanding subsection (1), the wage paid to an apprentice shall not be less than the minimum wage fixed pursuant to The Employment Standards Act.

(3) An employer is not required to pay wages to an apprentice during the time that the apprentice spends attending the technical training courses prescribed by the Board.

9 The hours of work and working conditions of an apprentice shall be the same as those of a journeyman.

PART 2

CERTIFICATION

10 In accordance with section 31(b) of the General Regulations, the Director may issue the following class of certificate in the trade:

(a) Certificate of Qualification.

11 In accordance with section 32(d) of the General Regulations, the Director may issue a Certificate of Qualification for the trade without examination to a person who holds

(a) a Certificate of Completion of Apprenticeship in the trade issued by another province within Canada, or

(b) a Certificate of Qualification or a Certificate of Proficiency in the trade issued by another province within Canada bearing an Interprovincial Standards Red Seal.

12 An application to take an examination for a Certificate of Qualification shall be made to the Director.

(2) Documentary evidence acceptable to the Director shall be presented by an applicant for an examination showing that the applicant

(a) holds a certificate equivalent to an Alberta Certificate of Qualification issued by a provincial authority outside of Alberta, or

(b) has at least 4 years of acceptable work experience in the trade.

(3) The applicant shall provide translations into the English language, acceptable to the Director, of credentials other than in English submitted pursuant to subsection (2).

13 A Certificate of Qualification issued under these regulations is effective unless cancelled or suspended by the Director in accordance with section 42 or 43 of the General Regulations.

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